Break-it, hack-it, make-it: the ‘Hack-a-Thing’ workshop series as a showcase for the integration of creative thinking processes into FabLab Genk

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FabLabs are mostly known for their problem-solving approach since they allow people to develop and perfect a prototype of ‘almost any product’, using the available infrastructure, facilities and knowhow (Mandavilli, 2006). Since 2012, FabLab Genk too has become a hotbed for problem-solving activities. FabLab Genk is situated in a creative context and is used by many media, arts and design students, researchers, designers and artists, for creating a wide variety of physical objects that they could otherwise only imagine. However, we noticed that the creative thinking processes that occur before the actual problem-solving do not take place within the environment of FabLab Genk. As a way of including these creative thinking processes into its environment, FabLab Genk organised a series of workshops called ‘Hack-a-Thing’. This paper shows how ‘Hack-a-Thing’ proved to be a setup that facilitates new ways of learning and creative thinking in the environment of FabLab Genk. First, this paper illustrates that the ‘Hack-a-Thing’ workshop series allowed FabLab Genk to become an environment that fosters a new, more informal and creative form of learning. Second, this paper shows how ‘Hack-a-Thing’ stimulated a more creative way of using and thinking, particularly about alternative relationships with technological objects.

Keywords: *FabLab; workshops; creative thinking processes; learning; thinking*

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Introduction: personal fabrication, FabLab Genk and creative processes outside of the FabLab

According to Neil Gershenfeld (2005), the digital revolution lies behind us and we have entered an era of personal fabrication. Personal fabrication means that we can download or develop digital product descriptions and designs, and supply these to the fabricator with the raw materials to process them. Personal fabrication indicates that we can make (almost) everything (Gershenfeld, 2005; Mikhak, Lyon, Gorton, Gershenfeld, McEnnis and Taylor, 2002). In this line of thought, Gershenfeld launched a project to create so-called 'FabLabs': Fabrication (or Fabulous) Laboratories that are globally dispersed open workplaces aiming to explore the implications and applications of personal fabrication. Personal fabrication creates the opportunity for mass production, a scenario where one could design and produce his/her own objects (Seravalli, 2011). Gershenfeld defines a FabLab as '*a collection of commercially available machines and parts link by software and processes we developed for making things*' (2005, p. 12). A FabLab allows people to develop and perfect a prototype of almost any imaginable product. Therefore, FabLabs are mostly known for their problem-solving approach since they allow people to develop and perfect a prototype of almost any imaginable product, using the available infrastructure, facilities and knowhow (Mandavilli, 2006). Access to the lab and its cutting edge equipment is absolutely free, including the training one can follow to get acquainted with the hard- and software (Milanese, 2006), provided that the FabLab user shares his/her designs (via the internet) with others in the form of 'fabmoments'. Documentation and digitally sharing designs places FabLabs in the context of open source: a philosophy, but also a pragmatic method of creation, via which organisations or individuals provide free access to source materials of a thing to a distributed network of people (Bauwens, 2007; Tribe and Jana, 2006; Open source initiative, 2010).

Inspired by Gershenfeld's initiative, the Euregional project 'Fablabs in the border region' (including Dutch and Belgian partners) sets as one of its primary goals to stimulate the collaboration between students and researchers with local industry and social economy. Furthermore, it aims to support innovation and encourage entrepreneurship among young people by giving them a chance in realising a first small series of products. FabLab Genk (www.fablagenk.be) is a local FabLab that has been set up as part of this project. It is currently fully operational and open for everyone.

FabLab Genk is situated at C-mine, a creative site in the city of Genk (BE) on which education, artistic creation and presentation, creative economy and creative recreation are represented through many creative organisations, cultural centres, recreation facilities and academic institutions that are housed on the site. Because of this creative environment where the FabLab is situated in, the visitors of FabLab Genk are mainly students, teachers, researchers, designers, artists and people from the creative industries.

In contrast to its expectations, throughout the years we experienced that - although it is situated in an environment designed to stimulate artistic and creative activities - the artistic and creative processes do not take place within the environment of the FabLab itself. Instead, it became clear that FabLab Genk - its infrastructure, spaces and knowhow - is mainly used for the final phase of a process or project. This means that, corresponding to the FabLab philosophy as envisioned by Gershenfeld (2005), the visitors use FabLab Genk in a problem-solving way. For instance, as a part of a research project into low-tech designs and tools that assist a person with dementia to live longer and in a qualitative manner in the home environment, the art and design researchers of MAD-faculty used FabLab Genk in order to create a prototype of a rolling walker (http://www.fablabgenk.be/node/2719).

However, the artistic and creative thinking processes that took place in the earlier phase of the research project and that preceded the development of the rolling walker, took place elsewhere. Before developing the prototype, the art and design researchers involved in the project organised participatory design sessions with potential end-users and workshops with designers. These brainstorming activities took place in the daily environment of the potential end-users (usually, care centres) or in the research institution of the researchers themselves. We noticed that this is the case for most of the research- and education-related activities that take place in the environment of FabLab Genk.

However, over the years, we have constantly strived for including the artistic and creative thinking processes that take place in the early phases of a process or project into the environment of the FabLab. We believe that, by doing so, we can stimulate exploration of different possible solutions and the generation of additional design alternatives that contribute to better results. As Obrenović (2011) explains, this turns the activity of making into Design Research, leading to solutions of a higher quality since '*though we cannot explain such [design and problem-solving] knowledge and skills, we can demonstrate them by being engaged in a particular activity*'. As an attempt to include the artistic and creative thinking processes into the environment of FabLab Genk, we organised a series of workshops - called

'Hack-a-Thing', as a part of the exhibition 'The Machine - Designing A New Industrial Revolution' (http://www.the-machine.be/).

In the following part, we discuss the 'Hack-a-Thing' workshops and explore how **the 'Hack-a-Thing' workshops facilitated the artistic and creative thinking processes to take place in the FabLab itself.** We first further explain the above-mentioned series of workshops. Subsequently, we discuss how the 'Hack-a-Thing' workshops were developed and based on pedagogical principles in combination with existing approaches, such as the 'Do-It-Yourself movement', 'Repair Cafés' and theories on constructionism and interdisciplinarity. We illustrate how this resulted in (1) new, more informal and creative forms of learning and (2) more creative ways of using and thinking about materials. Finally, we draw some conclusions and opt several suggestions (for the future).

In order to analyse the 'Hack-a-Thing' workshop we used the following methodology: based upon participant observations (DeWalt and DeWalt, 2010) and unstructured interviews with the participants of the Hack-a-Thing workshops, we formulated 'thick descriptions' (Geertz, 1973) that allowed us to relate our theoretical concepts to what was discussed and conducted during the workshops. In this way, not only the mere facts, but also interpretations of the workshop, the use of technology, results and comments were taken into account.

Break-it, hack-it, make-it: FabLab Genk and the 'Hack-a-Thing' series of workshops

The 'Hack-a-Thing' workshops started from the premise that people generally own a lot of old home appliances that are broken or not used anymore. As stated by Jackson and Kang (2014, p. 2): '*artifacts get designed, purchased, and adopted, but they also get fixed, discarded, and (sometimes) reused. Values get built into technology, but they still take work to maintain – and additional, sometimes alternative values may be introduced through ongoing acts of repurposing and reuse that humans routinely perform vis-à-vis the world of objects around them.* ' Therefore, the goal of 'Hack-a-Thing' was to create new, creative objects from parts of these old appliances, by enhancing them and finding new ways to operate and program them (De Weyer, Taelman, Luyten, Leen, Schepers and Dreessen, 2013).

In the first workshop (which took place on the 7th and 8th of July 2012) (local) youth (16-20 years old) from the city of Genk was targeted. All participants were invited to bring old, used and broken appliances or objects (a vacuum cleaner, a mobile phone, a printer, etc.) that they had lying around at home to FabLab Genk. Furthermore, prior to the workshop we also collected different objects and appliances that were broken or no longer used and electronics (sensors, LED lights, switches and other Arduino-components) as starting kits for the workshop. The goal of this first workshop was to create new devices from these old ones, which had another function than originally intended. The workshop started with an introduction to the soft- and hardware that was present in FabLab Genk (i.e. Arduino, a laser cutter, a 3D-Printer, a CNC mill, etc.) and enabled the workshop participants (approximately twenty youngsters) to make objects in a short period of time. After agreeing on a plan for repurposing a specific object, the groups of participants had the remainder of the weekend to effectively work out and realize their ideas. The second workshop (which took place on the 15th and 16th of September 2012) made use of an open call for participation in order to invite expert programmers, hackers and designers. The youngsters who participated in the first workshop series were - again - invited to work together with these experts or continue their work on the objects they had created during the first workshop. The setup used for this second workshop was significantly different from the first one. Potential participants were asked to submit a project plan and list the materials they would need to work out that plan (which were then provided by FabLab Genk). Because the participants in the second workshop already knew how to use the machines and electronics present in the Fablab, there was no need for an introductory workshop or crash course. Therefore, the second workshop was more hands-on.

The 'Hack-a-Thing' workshops resulted in several interesting outcomes, such as the 'Persistence of Vision Robot', 'The Toaster JukeBox' and 'The Etch-a-Sketch Robot' (all depicted in fig 1). One group of participants used an old, broken 'Roomba' (i.e. the autonomously, automatic vacuum cleaner robot sold by 'iRobot') as a starting point for their 'Persistence of Vision Robot'. They hacked the chassis and connected the vacuum cleaner's motors to a Motor Drive Shield. This Shield, connected to an Arduino, allowed the participants to control the robot's movements. Moreover, the participants attached a row of thirteen small, LED lights to a custom, laser cut wooden plate, which - subsequently - was placed on top of the robot.

The LED lights were connected to another Arduino, which determined whether or not and how fast the LED lights flickered. When the robot was photographed and a long shutter-time was used for taking the picture, the 'Persistence of Vision Robot' was seen writing 'FabLab Genk' in light. By adjusting the speed and sequence of the blinking of the LED lights, the robot was able to write any (short) fragment of text and even draw small graphical elements (in loop). Another group worked around ’The Toaster JukeBox’: an oven that makes music. Their concept included a musical instrument that automatically appears out of the oven when it is turned on. The youngsters connected an old oven and a control panel of a used household appliance to an Arduino, changing the analogue signals into digital ones. The last group of participants hacked a printer and used open hardware (Arduino and a motorshield) to work out their concept of an ‘Etch-a-Sketch’ drawing robot. By doing so, they created a robot that holds a pen and draws figures on the ground as it is driven across the room.

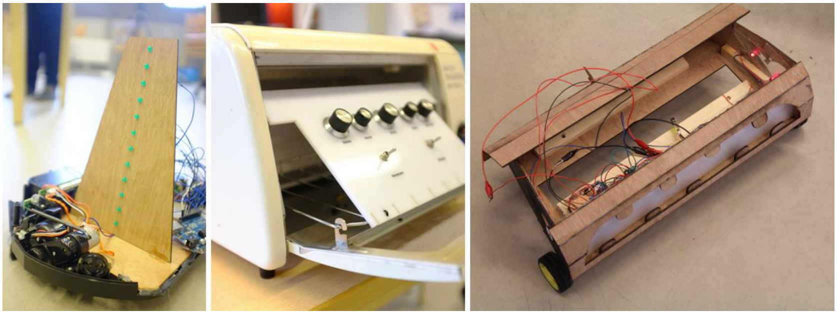

Figure 1 The ‘Persistence of Vision Robot’, ’The Toaster JukeBox’ and ‘The Etch-a-Sketch Robot’.

For setting up and organising the ‘Hack-a-Thing’ workshops in FabLab Genk, we were inspired by Blikstein (2013) who states that the philosophy of digital fabrication is based on several theoretical and pedagogical principles. Similarly, several principles and ideas formed the building blocks for the ‘Hack-a-Thing’ workshops in FabLab Genk:

(1) For exploring new and creative ways of thinking about materials, we investigated the ‘Do-It-Yourself movement’ and ‘Repair Cafés’. However, instead of creating something out of unprocessed, (semi-)raw materials (as is the case in typical Do-It-Yourself activities) or repairing broken home appliances (as is the case in repair activities) (König, 2013), we wanted to encourage the participants to start from (components of) an existing tool, appliance or infrastructure. This appeared to require a certain degree of ‘creative’ thinking, particularly about alternative relationships with technological objects.

(2) Inspired by Papert's theory of constructionism (1987), the 'Hack-a-Thing' workshops made use of a 'learning-by-doing' approach and departed from the idea that technology allows for new directions for learning. Finally, the participants in the workshop series collaborated in interdisciplinary teams.

We will now further clarify the abovementioned principles and ideas, illustrate how they took form in the 'Hack-a-Thing' workshops and show how they allowed us to include the creative thinking processes that take place before the actual problem-solving into the environment of FabLab Genk.

'Hack-a-Thing': DIY, Repair Cafés and creative ways of thinking

For the organisation and setup of the 'Hack-a-Thing' workshop series, we explored the 'Do-It-Yourself movement' and 'Repair Cafés' in order to enable new and creative ways of thinking. To illustrate this, we point out that it is widely acknowledged that people are driven to customize, modify and build things. According to Kuznetsov and Paulos (2010), the DIY movement '*predates recorded history as human survival itself often relied on the ability to repair and repurpose tools and materials. For hundreds of years, people have been fixing water leaks, remodelling their homes and decorating their clothes without hiring professional plumbers, architects or designers*' (2010, p. 295). In this sense, we define DIY as involving '*an array of creative activities in which people use, repurpose and modify existing materials to produce something*' (Buechley, Rosner, Paulos and Williams, 2009, p. 4823). Recently, through easy accessibility and affordability of tools and new sharing mechanisms facilitated by the emergence of - among other things - social computing and online sharing tools, the DIY movement has regained interest and wider adoption (Buechley, Rosner, Paulos and Williams, 2009). As a part of this DIY tradition, the origin of the Repair Café (http://repaircafe.org/) movement lies in the Netherlands, where Martine Postma - as a reaction to Europe's contemporary throw-away culture - organized a social event in 2012 during which people could come by with defunct or broken items and have them fixed by experts for free (Sharpe, 2012; König, 2013). According to Sharpe (2012), a part of the mission of Repair Cafés *'is teaching repair skills, which are lost quickly, so people who bring in broken items are asked to be active participants in their repair*'.

However, we felt that there is still a gap between the typical FabLab activities and the Do-It-Yourself activities. Namely, a FabLab starts from (mostly) unprocessed materials and not an existing tool, appliance or infrastructure. The 'Hack-a-Thing' workshops presented an opportunity to reflect on this. Therefore, instead of creating something out of unprocessed, (semi-)raw materials or repairing broken home appliances (König, 2013), we explicitly encouraged the participants to start from (components of) an existing tool, appliance or infrastructure (figure 2). This means that, although they all share the same starting point, the 'Hack-a-Thing' workshops differ from the traditional DIY and Repair Café movements in goal and realization.

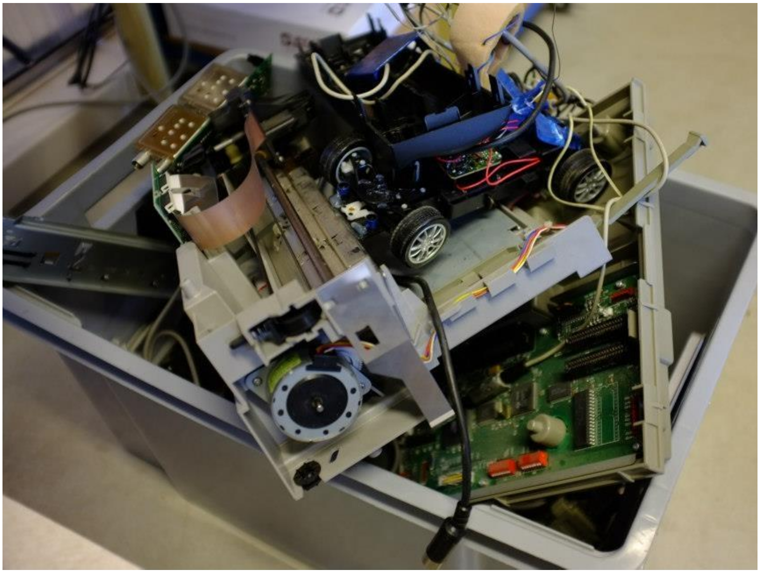

Figure 2 The 'Hack-a-Thing' workshop series departed from (components of) existing tools, appliances and infrastructure.

For instance, in contrast to the Repair Café, the 'Hack-a-Thing' workshops suggest alternative relationships with technological objects. Normally, technologies are designed to function and we want them to. But this also locks '*objects into a world of necessary dependencies that limits the kinds of relations we may imagine with them*' (Jackson and Kang, 2014, p. 9).

With the 'Hack-a-Thing' workshops, we explicitly not limited ourselves to repairing objects to their predefined lives. Instead, the 'Hack-a-Thing' workshops wanted to stimulate processes of creative breakdown and reuse that can unleash the other lives of technologies: i.e. the lives that go further than the ones they were designed for (Jackson and Kang, 2014). This means that starting with an existing item that fulfils a certain purpose often makes it even harder to imagine how it can be transformed to serve another purpose. As Jackson and Kang (2014, p. 6) state, such repurposing processes '*require forms of imagination and creativeness*' that reflect each participant's ideas of aesthetic and visions. Therefore, in contrast to traditional Do-It-Yourself activities and Repair Cafés, 'Hack-a-Thing' required an even higher degree of 'creative' thinking to come up with other uses than the objects original purpose.

'Hack-a-Thing': constructionism, interdisciplinarity and new ways of learning in a FabLab

In order to foster a creative thinking process, FabLab Genk found the principle of constructionism to be especially relevant for organising the 'Hack-a-Thing' workshop series. Constructionism - particularly attributed to Papert (1987) - is a learning theory that centralizes the construction of mental models by learners in order to understand the world around them. Inspired by this theory, the 'Hack-a-Thing' workshops made use of a 'learning-by-doing' approach and departed from the idea that technology allows for new directions for learning. Finally, the participants in the workshop series collaborated in interdisciplinary teams. We explain these three aspects and illustrate how they resulted in a new, informal and creative form of learning in the environment of FabLab Genk.

First, a 'learning-by-doing' (or 'learning-by-making') approach is a central notion in constructionism. As Papert states: 'one of my central mathetic tenets is that the construction that takes place 'in the head' often happens especially felicitously when it is supported by construction of a more public son 'in the world'. (…) Part of what I mean by 'in the world' is that the product can be shown, discussed, examined, probed, and admired' (Papert, 1993, p. 142). According to Blikstein (2013), Papert's constructionism dictates that the construction of knowledge happens remarkably well when students build and make things. Papert (1999) claims, 'we all learn better when learning is part of doing something we find really interesting. We learn best of all when we use what we learn to make something we really want'. Inspired by this notion, the 'Hack-a-Thing' workshops stimulated a learning-by-doing approach. Although the making processes of the participants was preceded by an introduction in the soft- and hardware in the FabLab and a brainstorm for agreeing on a common project plan, we noticed that the participants learned more by actually using the soft- and hardware and by effectively working out their plans. Naturally, this involved an amount of trial-and-error during which the participants resorted to the workshop moderators (who - among other things - offered them technical support and advised them on (the feasibility of) their plans) or the Internet in order to solve problems on the spot. From feedback by the participants, we noticed that the participants found this 'search' to be particularly interesting.

Second, a pioneer in the use of digital technologies in education, Papert (1999) departs from the idea that technology allows for new directions for learning: '*if you can use technology to make things you can make a lot more interesting things. And you can learn a lot more by making them'* (Papert, 1999). According to Papert, technology enables students to design, engineer, and construct and caters to many forms of working, expressing, and building (Blikstein, 2013). As constructionism particularly applies to learning with digital technology (Stager, 2012), we set up the 'Hack-a-Thing' workshop series in such a way that technology was indispensable during the creative processes of the participants. The original purpose of Fab Labs is often considered to be an accessible infrastructure for digital fabrication. Fab Labs often drive innovations because they provide people with accessible tools and machines to experiment with and create new things. Therefore, as mentioned above, the workshops started with an introduction to the soft- and hardware that was present in FabLab Genk, which enabled the workshop participants to make objects in a short period of time. This led to new, innovative and unexpected outcomes (as described above, figure 1). Also, getting to know the technology in the FabLab resulted in participants having a better idea of the potential of a FabLab.

Finally, we organised the 'Hack-a-Thing' workshops in such a way that the twenty participating youngsters were divided into four groups, each containing a mix of participants from diverse disciplines and with different backgrounds (e.g. a designer, a programmer, a technician and an artist), in order to brainstorm on repurposing their objects (figure 3). Every group was moderated by an expert in programming, designing objects, fabrication techniques, etc., who guided the participants in their brainstorm sessions and advised them on (the feasibility of) their plans. As Lattuca, Voight and Fath (2004) show, interdisciplinary activities are more engaging that disciplinary ones because they capture intellectual interest and help to connect information from different disciplines. According to Newell (1994), interdisciplinarity even increases creative or original thinking. From feedback by the participants, we noticed that the participants learned a lot from their fellow-group members. We found that the creation of an interactive object adds a significant degree of complexity and lead to intense collaborations between participants. Since most of the participants’ projects targeted the creation of an interactive system, participants were required that had basic knowledge of electronics and programming. The creation of these interactive objects added a significant degree of complexity and led to intense collaborations between participants. We observed that, in such an interdisciplinary setup, the participants learned about other viewpoints on the same problem from their fellow-group members that came from different backgrounds.

Figure 3 The participants of the ‘Hack-a-Thing’ workshop series worked together in an interdisciplinary way.

Discussion

From the ‘Hack-a-Thing’ workshops we learned that the environment of a FabLab could be very beneficial to stimulate learning-by-doing (or learning-by-making) approaches. Since Papert's constructionism (1987) starts from the idea that the construction of knowledge occurs when participants build and make things, we deliberately chose to setup the workshops in this FabLab setting. In this way, the participants had easy access to the different available machines and technologies from the start.

This easy access resulted in the early use of technology by the participants: even during the brainstorm session some groups already made use of the FabLab infrastructure to visualise or materialise their concepts. Since we noticed that access alone is insufficient, incorporating the workshops into a FabLab environment provided the participants with enough time, space and assistance to use and experiment with the technologies. In this way, the participants were able to develop additional skills (e.g. in programming or in using electronics) and go through processes of trial-and-error. We believe that including experimentation and trial-and-error in these types of workshops (thus incorporating them in a FabLab setting) could result in more elaborate, reworked and tested prototypes (in respect to the degree of materialisation or finishing). However, more research needs to be conducted to test this claim. Additionally, by including the artistic and creative thinking processes into the environment of a FabLab, we go a step further than the problem-solving approach that FabLabs are mostly known for (Gershenfeld, 2005).

Conclusion

In this paper, we discussed the 'Hack-a-Thing' workshop series as a tool for informal learning and creative thinking. The workshop series focused on using various skills to repurpose broken things, giving them a new meaning and even a new identity. This transformation, where participants recycled the material and basic components of a broken thing into something new, turned out to be a very engaging activity. As one of the participants remarked: '*creating new objects, is more than just a hobby for us. As a student, you do not have a lot of money. We need to work with parts from discarded appliances. But that only makes it more fun*' (Nelis, 2012). As mentioned above, this contrasts to the traditional Do-It-Yourself movement and Repair Cafés, which all focus on creating repairing existing things or create new things from raw materials. In contrast, the 'Hack-a-Thing' workshop series did not start from the idea that things need to be repaired or created, rather that many things can be repurposed. This required us to create a specific setting that enabled people to leap forward and come up with unusual new ways to use and repurpose broken things. We believe the combination of a FabLab environment and people from various backgrounds and disciplines collaborating hands-on within this environment are the key factors that have lead to a successful workshop series. We found that participants learned to think beyond the traditional making activities and elaborated more on idea and implementation before exploring various alternatives. We noticed that this resulted in creative thinking processes taking place within FabLab Genk itself, that did not take place there before. The side effect appeared to be people becoming more aware of the consequences of their maker activities and consciously strived for a more sustainable approach.

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